Aerosol Research Branch (ARB) 48 inch Lidar (ARB_48_IN_LIDAR) Langley DAAC Data Set Document

Summary:

The ARB_48_IN_LIDAR data set contains data collected from a 48-inch lidar system located at NASA Langley Research Center. Each granule consists of one year of data. Data are available from 1982 through the present. Data are continuously being collected. The days of data are different in each granule. Each measurement consists of four parameters: integrated backscatter over altitude, altitude levels, scattering ratio at each altitude level, and aerosol backscattering coefficient at each altitude level. An image has been produced to represent the data collected for each granule.

Table of Contents:

1. Data Set Overview:

Data Set Identification:

ARB_48_IN_LIDAR	Aerosol Research Branch (ARB) 48 inch Lidar

Data Set Introduction:

This document summarizes measurements obtained using the ground-based 48-inch lidar system operated at 694 nm at the NASA Langley Research Center in Hampton, Virginia from 1982 to the present.

Objective/Purpose:

Routine ground-based lidar measurements have been taken at the Langley Research Center, Hampton, Virginia (37.1 degrees North, 76.3

degrees West), since May 1974. (Measurements prior to 1982 are not currently available in digital forms.) These lidar measurements provide high-resolution vertical profiles of the stratospheric and upper tropospheric aerosols. The lidar system, often referred to as the 48-inch lidar system because of its 48-inch telescope, has evolved over the years and provides a valuable long-term history of the mid-latitude stratospheric aerosol.

Summary of Parameters:

The lidar parameters provided for each measurement profile of approximately 100-200 laser shots are: altitude (km), scattering ratio, aerosol backscattering coefficient (1/km-sr); and integrated backscatter (1/sr), all at a wavelength of 694 mm.

Discussion:

The lidar backscatter ratio (or scattering ratio) is defined as (Equation 1)

$$R(z) = (B_A(z) + B_M(z)) / B_M(z) = 1 + B_A(z) / B_M(z)$$

where B_A is the aerosol backscattering function, or scattering function, and B_M is the molecular backscattering function, both in units of $(km\text{-}sr)^{-1}$ and both at altitude z. The function $B_M(z)$ is calculated from a temperature-pressure profile obtained from the radiosonde launch at Wallops Island, Virginia (120 km northeast of the lidar system), just prior to or just after the lidar data are collected. The scattering ratio $R(z)$ is calculated by evaluating (Equation 2)

$$R(z) = kS(z)z^2 / B_M(z)q^2(z)$$

where $S(z)$ is the lidar signal received from altitude z, $q^2(z)$ is the two-way atmospheric transmittance, and k is a system constant determined by normalizing the right-hand side of equation (2) to an expected minimum value of R (R_{min}) over a specified altitude range. The transmittance $q^2(z)$ is calculated from a combination of radiosonde-derived molecular extinction, model or lidar-derived aerosol extinction, and model ozone absorption. During periods of background or moderate aerosol loading, aerosol extinction can be adequately modeled. However, since the eruptions of El Chichon in late March-early April 1982, aerosol extinction has been calculated directly from the aerosol backscattering function. The lidar equation (2) is solved three times using an updated value for aerosol extinction for the second and third iterations. The integrated aerosol backscatter is defined as (Equation 3)

$$\int_{h_T}^{30km} B_A(z)dz$$

where B_A is the aerosol backscattering function $(km\text{-}sr)^{-1}$ at altitude z, and h_T is the height of the tropopause.

Related Data Sets:

A smaller version (a 14-inch telescope) of this ground-based system has been used for airborned observations of the stratospheric aerosol and polar stratospheric clouds.

2. Investigator(s):

Investigator(s) Name and Title:

Dr. Chris Hostetler, PI, ARB, NASA Langley Research Center

Title of Investigation:

Aerosol Research Branch (ARB) 48-inch Lidar

Contact Information:

Dr. Chris Hostetler
Atmospheric Science - Aerosol Research Branch
Mail Stop 420
NASA Langley Research Center
Hampton, VA 23681
USA
Telephone: (757) 864-5373
E-mail: chris.a.hostetler@nasa.gov

3. Theory of Measurements:

Lidar measurements are analyzed according to the method outlined by P. B. Russell, T. J. Swissler, and M. P. McCormick in "Methodology for error analysis and simulation of lidar aerosol measurements," Applied Optics, Vol 18, no 22, November 15, 1979.

4. Equipment:

Sensor/Instrument Description:

The 48-inch lidar system consists of a 48-inch (1.22-m) Cassegrainian telescope and a ruby laser that nominally emitted 1 joule per pulse at a wavelength λ of 694 nm at a repetition rate of 0.15 Hz. The divergence of the transmitted beam is approximately 1.0 mrad, and the maximum receiver field of view is 4.0 mrad. The electronic bandwidth of the receiver is 1 MHz, which provides a 150-m vertical resolution. Three photomultiplier tubes, electronically switched on (gated) at different deleay times after laser firing, are used to provide a large dynamic range. The photomultiplier tube output signals are processed by 12-bit Computer Automated Measurement and Control (CAMAC) based digitizers and acquired by a personal computer. The data are archived on optical discs.

Collection Environment:

Nighttime; no dense clouds.

Source/Platform:

The 48-inch lidar system is contained in a building and operated through a hole in the roof.

Source/Platform Mission Objectives:

This information is not available.

Key Variables:

This information is not available.

Principles of Operation:

Measurements are obtained weekly, weather permitting.

Sensor/Instrument Measurement Geometry:

Vertical profiles.

Manufacturer of Sensor/Instrument:

This information is not available.

Calibration:

Specifications:

This information is not available.

Tolerance:

This information is not available.

Frequency of Calibration:

This information is not available.

Other Calibration Information:

This information is not available.

5. Data Acquisition Methods:

Approximately 100-200 laser shots are averaged into one measurement data set.

6. Observations:

Data Notes:

This information is not available.

Field Notes:

This information is not available.

7. Data Description:

Spatial Characteristics:

Spatial Coverage:

Data Set Name	Min Lat	Max Lat	Min Lon	Max Lon
ARB_48_IN_LIDAR	37.10	37.10	-76.30	-76.30

Spatial Coverage Map:

This information is not available.

Spatial Resolution:

This information is not available.

Projection:

This information is not available.

Grid Description:

This information is not available.

Temporal Characteristics:

Temporal Coverage:

Data Set Name	Begin Date	End Date
ARB_48_IN_LIDAR	01/05/1982	11/23/1994 (on going)

Temporal Coverage Map:

This information is not available.

Temporal Resolution:

This information is not available.

Data Characteristics:

Parameter/Variable:

Parameter Name	Min Value	Max Value	Units
Integrated Backscatter	0.0	1.E-1 (or 0.1)	1/sr
Altitude	0.0	33.0	Kilometers
Scattering Ratio	-1000.0	1000.0	Unitless
Aerosol Scattering Coefficient	-1.E-1 (or -0.1)	1.E-1 (0.1)	1/(km-sr)

Variable Description/Definition:

See above.

Unit of Measurement:

See above.

Data Source:

This information is not available.

Data Range:

See above.

Sample Data Record:

```
DATE (GMT)  # ALTITUDES  INT BCKSC (1/sr)
     61482       221        7.74E-4

ALT(km)  SCATT RATIO  AER COEFF(1/km-sr)
  0.00     9999.000        9.9990E+03
  0.15     9999.000        9.9990E+03
  0.30     9999.000        9.9990E+03
...
  4.05        1.060        2.0945E-05
  4.20        1.051        1.7657E-05
  4.35        1.033        1.1072E-05
  4.50        1.021        7.1247E-06
  4.65        1.037        1.2286E-05
  4.80        1.066        2.1401E-05
  4.95        1.105        3.3442E-05
...
```

8. Data Organization:

Data Granularity:

Each granule consists of one year of data.
A general description of data granularity as it applies to the Information Management System (IMS) appears in the EOSDIS Glossary.

Data Format:

All data granules are in ASCII format.

9. Data Manipulations:

Formulae:

Derivation Techniques and Algorithms:

This information is not available.

Data Processing Sequence:

Processing Steps:

This information is not available.

Processing Changes:

There are no plans for reprocessing.

Calculations:

Special Corrections/Adjustments:

This information is not available.

Calculated Variables:

This information is not available.

Graphs and Plots:

There is a browse product available for each granule in this data set.

10. Errors:

Sources of Error:

Derivation of scattering ratios is subject to a number of uncertainties arising from the measurements themselves and from the assumptions used in the data analysis. The random error in the scattering ratio contains contributions from signal measurement error, error in the correction for two-way transmittance, density errors, and error in the assumed value of R_{min}. The magnitude of these errors is related to the amount of aerosol loading, the proximity in time and space to a measured molecular density profile, the number of laser shots averaged together in a sequence, the background lighting conditions, and the models used for atmospheric attenuation.

Quality Assessment:

Data Validation by Source:

This information is not available.

Confidence Level/Accuracy Judgement:

This information is not available.

Measurement Error for Parameters:

This information is not available.

Additional Quality Assessments:

This information is not available.

Data Verification by Data Center:

The Langley DAAC performs an inspection process on this data received by the data producer via ftp. The DAAC checks to see if the transfer of the data completed and were delivered in their entirety. An inspection software was developed by the DAAC to see if the code was able to read every granule. The code also checks to see if every parameter of data falls within the ranges which are included in the granule. This same code extracts the metadata required for ingesting the data into the IMS. If any discrepancies are found, the data producer is contacted. The discrepancies are corrected before the data are archived at the DAAC.

11. Notes:

Limitations of the Data:

There are no known limitations or unreliable aspects in the algorithms implemented to generate the 48-inch lidar science data.

Known Problems with the Data:

There are no known problems or inconsistencies in the ERBE data.

Usage Guidance:

This information is not available.

Any Other Relevant Information about the Study:

This information is not available.

12. Application of the Data Set:

This information is not available.

13. Future Modifications and Plans:

Additional granules will be added to the archive list as data become available.

14. Software:

Software Description:

Sample read software is available for this data set. This code is written in C. A makefile and a readme file are also available to work with the code and data.

Software Access:

The software can be obtained through the Langley DAAC. Please refer to the contact information below. The software can also be obtained at the same time the user is ordering this data set.

15. Data Access:

Data Center Identification and Contact Information:

Langley DAAC User and Data Services Office
NASA Langley Research Center
Mail Stop 157D
Hampton, Virginia 23681-2199
USA
Telephone: (757) 864-8656
FAX: (757) 864-8807
E-mail: support-asdc@earthdata.nasa.gov

Procedures for Obtaining Data:

Data, programs for reading the data, and user's guides can be obtained through the EOSDIS Langley DAAC on-line system which will allow users to search through the data inventory and place orders on-line.

Langley DAAC User and Data Services Office
NASA Langley Research Center
Mail Stop 157D
Hampton, Virginia 23681-2199
USA
Telephone: (757) 864-8656
FAX: (757) 864-8807
E-mail: support-asdc@earthdata.nasa.gov
URL: http://eosweb.larc.nasa.gov

The Langley DAAC User and Data Services staff provides technical and operational support for users ordering data.

Data Center Status/Plans:

The Langley DAAC will continue to archive this data.

16. Output Products and Availability:

There is a browse image for each granule of data archived at the Langley DAAC.

17. References:

- Fuller, W. H., Osborn, M. T., and Hunt, W. H. *48-Inch Lidar Aerosol Measurements Taken at the Langley Research Center - May 1974 to December 1987.* NASA RP-1209, 1988.
- Osborn, M. T., R. J. DeCoursey, C. R., Trepte, D. M. Winker, and D. C. Woods, *Evolution of the Pinatubo Volcanic Cloud Over*

Hampton, Virginia, Geophys. Res. Lett., Vol. 22, No. 9, May 1, 1995, pp 1101-1104.
- Russell, Philip B., Swissler, Thomas J., and McCormick, M. Patrick, *Methodology for Error Analysis and Simulation of Lidar Aerosol Measurements*. Appl. Opt., vol. 18, no. 22, Nov. 15, 1979, pp. 3783-3797.
- Woods, D. C., M. T. Osborn, D., M. Winker, R. J. DeCoursey, and O. Youngbluth, *48-inch Lidar Aerosol Measurements Taken at the Langley Research Center - July 1991 to December 1992*. NASA RP-1334, 1994.

18. Glossary of Terms:

EOSDIS Glossary.

19. List of Acronyms:

DAAC - Distributed Active Archive Center
EOSDIS - Earth Observing System Data and Information System
ftp - File Transfer Protocol
IMS - Information Management System
LaRC - Langley Research Center
NASA - National Aeronautics and Space Administration
URL - Uniform Resource Locator

EOSDIS Acronyms.

20. Document Information:

- **Document Revision Date:** Jan 06, 1997; May 21, 1997; Nov 24, 1997
- **Document Review Date:** Jan 06, 1997
- **Document ID:**
- **Citation:**
- **Document Curator:** Langley DAAC User and Data Services Office
  Telephone: (757) 864-8656
  FAX: (757) 864-8807
  E-mail: support-asdc@earthdata.nasa.gov